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June 18, 1999

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By Messenger

Ms. Magalie Roman Salas  
Secretary  
Federal Communications Commission  
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Washington, D.C. 20554

RECEIVED  
JUN 18 1999  
FEDERAL COMMUNICATIONS COMMISSION  
OFFICE OF THE SECRETARY

Re: **EX PARTE**  
ET Docket 95-18

Dear Ms. Salas:

ICO Services Limited ("ICO") submits for the record in the above-captioned proceeding the attached paper, An Economic Analysis of Regulatory Takings and Just Compensation with an Application to Mobile Satellite Services, prepared at the request of ICO by Jan Paul Acton and Stanley M. Besen of Charles River Associates, Inc., an economics and business consulting firm.

Acton and Besen have conducted a detailed economic analysis concluding that the Commission's proposed requirement to compensate incumbent licensees for the full cost of new equipment would result in overcompensation and thus contravene the Commission's established policy of compensating incumbents only to the point where they would be "no worse off" than if relocation were not required. In addition, Acton and Besen offer a compensation formula that takes into account the economic depreciation of equipment, provides for cost sharing between incumbents and new Mobile Satellite Service ("MSS") entrants, and ensures that incumbents receive compensation that leave them neither better nor worse off as a result of relocation. Acton and Besen further suggest that, given certain assumptions and factors, their proposed compensation formula would yield a compensation amount equaling the cost of the original equipment multiplied by the remaining fraction of the equipment's useful life.

Acton and Besen's economic analysis and conclusions are premised on sound legal principles widely endorsed by both the courts and the FCC. Specifically, the courts have expressed an aversion to providing overcompensation and permitting

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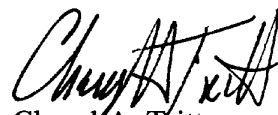
property owners to reap a windfall at the public's expense. In addition, the Commission, in providing compensation to incumbents displaced by Personal Communications Service licensees, declared that its goal is to ensure that incumbents are made "no worse off," and not to provide incumbents with superior equipment. In establishing rules governing Open Video Systems, the Commission also endorsed the "before and after" test, which ensures that the measure of compensation is the difference between the market values of the property before and after a taking. Thus, in reaching their conclusions, Acton and Besen rely on ample precedent requiring the Commission to consider a compensation approach that accounts for the economic depreciation of equipment and provides for appropriate cost sharing between incumbents and MSS entrants.

The Acton-Besen analysis and conclusions support and expand upon ICO's position, stated in previous pleadings filed in the above-captioned proceeding, that compensation given to incumbents should only leave them no worse off than before relocation and should take into account the economic depreciation of equipment.<sup>1</sup>

The Economic Analysis assumes that incumbent licensees have property rights in spectrum, including perpetual rights of renewal. To the extent that these assumptions are not accepted, any compensation to incumbent licensees would be reduced.

An original and one copy of this letter have been submitted to the Secretary of the Commission for inclusion in the public record, as required by Section 1.1206 (b)(2) of the Commission's Rules.

Very truly yours,



Cheryl A. Tritt  
Counsel for ICO Services Ltd.

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<sup>1</sup> See, e.g., ICO Consolidated Reply Comments to Oppositions to and Comments on Petitions for Reconsideration and Clarification, ET Docket No. 95-18, at 9 (Mar. 8, 1999); ICO Comments, ET Docket No. 95-18, at 14 (Feb. 3, 1999); Reply of the MSS Coalition, ET Docket No. 95-18, at 8-9 (July 2, 1997); Further Comments of the MSS Coalition, ET Docket No. 95-18, at 8-9 (June 23, 1997).

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Attachment

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**AN ECONOMIC ANALYSIS OF REGULATORY TAKINGS AND JUST COMPENSATION  
WITH AN APPLICATION TO MOBILE SATELLITE SERVICES**

Jan Paul Acton  
Stanley M. Besen

Charles River Associates Incorporated

June 18, 1999

## INTRODUCTION

The Federal Communications Commission has determined that Mobile Satellite Service (MSS) may be provided by new entrants using frequencies currently assigned to broadcast auxiliary service (BAS) for electronic newsgathering (ENG) and other services, and to fixed link terrestrial microwave services. Because this will require reassignment of the incumbents to other frequencies, the Commission has also determined that MSS entrants should initially negotiate to effect voluntary relocations but that, if negotiations fail to produce a timely agreement, incumbents may be involuntarily relocated.<sup>1</sup> When relocation occurs, MSS entrants must provide compensation to incumbents. Consistent with past government policies regarding regulatory "takings," and with its own past policies, the Commission has determined that this compensation must leave incumbents "no worse off" than they would be if relocation were not required.<sup>2</sup>

ICO Global Communications Services Inc. (ICO) has retained us to conduct an economic analysis of how the Commission's policy should be applied in these circumstances. We conclude that the Commission's proposed approach to implementing its policy generally results in overcompensation of incumbents. In this

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<sup>1</sup> Amendment to Section 2.106 of the Commission's Rules to Allocate Spectrum at 2 GHz Use by the Mobile-Satellite Service, ET Docket No. 95-18, First Report and Order and Further Notice of Proposed Rule Making, 12 FCC Rcd 7388 (1997) (hereafter "First R&O/further NOPR"); and *Ibid.*, Memorandum Opinion and Order and Third Notice of Proposed Rule Making and Order, FCC 98-309, Released November 27, 1998 (hereafter "Memorandum Opinion and Order/Third NOPR & Order").

<sup>2</sup> Amendment to the Commission's Rules Regarding a Plan for Sharing the Costs of Microwave Relocation, WT Docket No. 95-157, RM-8643, First Report and Order and Further Notice of Proposed Rule Making FCC 96-196, Adopted April 25, 1996, Released April 30, 1996 (hereafter "Cost Sharing First R&O/further NOPR"), Para. 32.

report, we provide an economic analysis that supports this conclusion. We also present a compensation formula that would, if implemented by the Commission, ensure that incumbents were made neither better nor worse off as a result of the entry of MSS providers.

Our analysis is based on the assumption that the incumbents have a valid reason to expect their licenses to be renewed. Specifically, for purposes of discussion, our analysis assumes that incumbents have property rights in spectrum, including a perpetual right of renewal, so that the federal law on “takings” applies to the question of just compensation. To the extent that renewal is not assured, the compensation formula presented below leads to overcompensation of incumbents.<sup>3</sup>

We begin our analysis by reviewing the legal principles that underlie the appropriate amount of compensation to be paid to those who experience regulatory takings. We also briefly describe the FCC’s own analysis of the same issue in its Open Video Systems decision, which applies these principles. We then present a general economic framework that shows how these principles can be applied to determine the amount of just compensation in the case of regulatory takings. Finally, we apply the legal and economic principles to the specific case of spectrum reallocation for MSS.

Consistent with sound economic principles and previous court opinions, we find that displaced incumbents should receive the lower of (a) the cost of modifying their current equipment or (b) the (correctly calculated) market value of any equipment that

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<sup>3</sup> At various times, courts have held that government actions affecting FCC licenses do not involve takings because licensees have no property interest in their licenses. See *FCC v. Sanders Brothers Radio Station*, 309 U.S. 470, 475 (1940); *APT Tampa/Orlando, Inc. v. Orange County*, 1997 U.S. Dist. LEXIS 22096 (Mid. Dist. Fla. Dec. 10, 1997).

must be replaced plus the cost, if any, of additional equipment, required to operate at the new frequency. Contrary to the Commission's proposal to compensate BAS and terrestrial microwave incumbents for the entire cost of the facilities they purchase to operate at the new frequencies, we find that incumbents should generally be required to share in this cost except in highly unusual circumstances. Because the Commission's proposed compensation formula does not provide for cost sharing, it is overly generous to incumbents.<sup>4</sup>

Cost sharing, which will ensure that incumbents receive the amount of compensation that makes them neither better nor worse off as a result of the frequency reassignment, is required whenever the equipment employed by an incumbent at its new frequency assignment has a longer service life or greater functionality than the equipment used at the previously assigned frequency. As the Supreme Court has previously noted, incumbents displaced by takings should not be compensated for the amount by which "the new facility itself will be more valuable and last longer" than the facility it replaces.<sup>5</sup> Courts have further explained that, when just compensation is awarded, no citizen has a right to "reap a windfall," as "overcompensation is as unjust to the public as undercompensation is to the property owner."<sup>6</sup> If the amount of compensation that MSS providers are required to pay disregards these factors, so that incumbents do not share in the costs of longer-lived or improved equipment, MSS entry may be delayed, may occur at a reduced scale, or may not occur at all, thus preventing

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<sup>4</sup> This is in addition to any overcompensation that results from treating license renewal as assured.

<sup>5</sup> *United States v. 564.54 Acres of Land, More or Less, Situated in Monroe and Pike Counties, Pennsylvania, et al.*, 99 S. Ct. 1854 (1979) at 1860 (note omitted).

<sup>6</sup> *United States v. 69.1 Acres of Land*, 942 F.2d 290, 292 (4<sup>th</sup> Cir., 1991).

the achievement of the goals sought by the Commission when it adopted the reassignment policy.

The method we propose for determining the appropriate level of cost sharing, and thus the appropriate amount of compensation, provides objective means for calculating the respective shares of the costs of new equipment that should be borne by incumbents and new licensees and is consistent with methods used in other instances of governmental takings. The method allows the Commission to take into account differences in the circumstances of individual incumbents without imposing unduly large administrative burdens.

## **THE PRINCIPLE OF JUST COMPENSATION**

The FCC has clearly articulated its goal in providing compensation for displaced incumbents in its Order requiring Personal Communications Service (PCS) providers to compensate microwave incumbents that were relocated to accommodate PCS:

In sum, our goal is to ensure that incumbents are no worse off than they would be if relocation were not required, not to guarantee incumbents superior systems at the expense of PCS licensees.<sup>7</sup>

The FCC subsequently confirmed this goal for the case in which incumbents must be relocated to accommodate MSS providers.<sup>8</sup>

Similarly, the Courts have held for many years that the amount of compensation to be paid to entities that experience regulatory taking should leave them neither better nor worse off. In *Olson*, for example, the Supreme Court sought to put the owner of

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<sup>7</sup> Cost Sharing First R&O/further NOPR, Para. 32.

<sup>8</sup> Memorandum Opinion and Order/Third NOPR and Order, Paras. 19 and 22.



condemned property “in as good a position pecuniarily as if his property had not been taken. He must be made whole *but is not entitled to more.*”<sup>9</sup>

The Supreme Court reaffirmed this principle in *564.54 Acres of Land*<sup>10</sup> when it held that

...allowing respondent the fair market value of its property, *rather than the cost of substitute facilities*, is consistent with the principles of fairness underlying the Just Compensation Clause of the Fifth Amendment.<sup>11</sup>

In his concurring opinion, Justice White wrote that

...I do not understand how a duty to replace the condemned facility justifies paying more than market value. Obviously, replacing the old with a new facility will cost more than the value of the old, *but the new facility itself will be more valuable and last longer.*<sup>12</sup>

In a survey of the legal principles underlying just compensation, the Congressional Research Service notes that “the Constitution...is concerned about awards of compensation that are too large, in addition to those that are too small.”<sup>13</sup> Citing the *564.54 Acres of Land* decision as well as a later case affirming its principle,<sup>14</sup> CRS noted “... the Court’s aversion to giving condemnees what it sees as a windfall at public expense.”<sup>15</sup>

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<sup>9</sup> *Olson v. United States*, 292 U.S. 246, 54 S. Ct. 704 255 (1934), emphasis added.

<sup>10</sup> *United States v. 564.54 Acres of Land, More or Less, Situated in Monroe and Pike Counties, Pennsylvania, et al.*, 99 S.Ct. 1854 (1979).

<sup>11</sup> *Id.* at 1854, emphasis added.

<sup>12</sup> *Id.* at 1860, emphasis added.

<sup>13</sup> Robert Meltz, Congressional Research Service Report for Congress, *When the United States Takes Property: Legal Principles* (hereafter CRS Report), March 20, 1990, revised March 22, 1991, Section 9.1.

<sup>14</sup> *United States v. 50 Acres of Land*, 469 U.S. 24 (1984) Ed. 2d 376.

<sup>15</sup> CRS Report, Section 9.5.

Academic writings on this subject have generally endorsed this view. Professor Richard Epstein has described the principle of *Olson* quoted above as “rightly stated.”<sup>16</sup> Epstein describes the “central purpose” of compensation as to leave the original owner “indifferent between retention of the basic property and the substitute award.”<sup>17</sup> He also observes that

...value is the universal measure of compensation. *Owners of depreciated properties do not increase the government obligation by retaining ownership.*<sup>18</sup>

Epstein also emphasizes the fact that any depreciation or appreciation in the value of the condemned property since the time it was purchased must be taken into account in determining just compensation. If appreciation is ignored

...the property owner is deprived of compensation for all or part of the appreciation in market value between the time of his original acquisition or improvement and the date of condemnation.<sup>19</sup>

At the same time, of course,

...the wrongdoer would not have to pay the original cost if the property had depreciated in value before the taking or destruction.<sup>20</sup>

Finally, Professor William Fischel has observed that

...the Takings Clause is less protective of private property than it is sometimes made out to be. The Takings Clause dictates that private property is protected only by a liability

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<sup>16</sup> Richard A. Epstein, *Takings: Private Property and the Power of Eminent Domain* (Cambridge, MA: Harvard University Press, 1985), p. 182.

<sup>17</sup> *Id.*, p. 184.

<sup>18</sup> *Id.*, p. 185, emphasis added.

<sup>19</sup> *Id.*

<sup>20</sup> *Id.*

rule with respect to the government or some other party granted the power of eminent domain. It allows property to be taken without consent....<sup>21</sup>

## THE FCC'S OPEN VIDEO SYSTEMS DECISION

In establishing rules governing Open Video Systems (OVS), the FCC addressed the issue of whether federal preemption of the authority of state and local governments to impose local cable franchising requirements constitutes a taking for which just compensation is due under the Fifth Amendment.<sup>22</sup> Although the Commission concluded that there was inadequate evidence in the record to support a conclusion that such federal preemption constitutes a taking, the FCC proceeded to declare that the Telecommunications Act of 1996 ("Telecom Act") provided just compensation to local authorities for use of the public rights-of-way by OVS operators.<sup>23</sup> Specifically, the FCC noted that the Telecom Act permits local authorities to collect from OVS operators fees based on their gross revenues in lieu of cable franchise fees. This gross revenue fee, according to the FCC, represents the fair market value for use of the public rights-of-way and satisfies the "before and after" test, which courts have used in partial takings cases to measure the adequacy of compensation. Under this test, "the measure of compensation is the difference between the value of the property before a partial taking

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<sup>21</sup> William A. Fischel, *Regulatory Takings: Law, Economics and Politics* (Cambridge, MA: Harvard University Press, 1995), pp. 67-68. Liability rules, where transfers require only compensation, are distinguished from property rules, where only voluntary transfers are permitted; in Guido Calabresi and A. Douglas Melamed, "Property Rules, Liability Rules, and Inalienability: One View of the Cathedral," 85 *Harvard Law Review* 1089 (1972). Fischel (id., p. 68) explains that "The major advantage of liability rules is that they cut through the holdout problem. Holdouts are endemic in public projects...in which many different properties must be acquired and alternative routes are limited. Preventing time-consuming strategic bargaining is an important justification for eminent domain."

<sup>22</sup> See *In the Matter of Implementation of Section 302 of the Telecommunications Act of 1996*, Second Report and Order, 11 FCC Rcd. 18333 (1996), CS Docket No. 96-46, Paras. 217-222.

<sup>23</sup> Id., Para. 217-18.

and the value of the remainder of the property after the partial taking.”<sup>24</sup> Moreover, the value of the property taken is to be measured by “the owner’s loss, not the taker’s gain.”<sup>25</sup>

In support of its use of the “before and after” test, the FCC cited a case in which the court addressed the issue of a governmental taking of an easement for a pipeline and held that “[w]hen the property interest taken from a parent tract is merely an easement, the proper measure of damages is still the before-and-after method of valuation, expressed as the difference between the market value of the land free of the easement and the market value as burdened with the easement.”<sup>26</sup> In applying the test to evaluate the compensation due for the taking of an easement for an OVS operator to install its wires over public rights-of-way, the FCC noted that “the proper measure is the decrease in the value of the public rights-of-way if they are crossed by an additional wire.”<sup>27</sup>

## **APPLYING THE PRINCIPLE OF JUST COMPENSATION**

Justice White’s concurring opinion in *564.54 Acres of Land* makes clear that, in order to determine the amount of compensation that avoids windfalls to an incumbent, it is necessary to allow for the fact that a new facility may either be more valuable or last longer than the one it replaces. Similarly, as Epstein emphasizes, both appreciation and depreciation of the property since the time of its purchase are relevant to

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<sup>24</sup> Id., Para. 221.

<sup>25</sup> Id. (quoting *First English Evangelical Lutheran Church v. County of Los Angeles*, 482 U.S. 304, 319 (1987)).

<sup>26</sup> Id. (quoting *United States v. 8.41 Acres of Land*, 680 F.2d 388, 391 (5th Cir. 1982)).

<sup>27</sup> Id., Para. 221.

determining just compensation. The framework we develop here takes these factors, and others, into account.

The compensation formula we present below was developed for the situation in which existing equipment must be completely replaced when the incumbent is relocated. If there is a less expensive alternative for achieving adequate functionality, however, compensation is limited to the cost of that alternative. For example, compensation is limited to the cost of modifying old equipment if that is less than the cost of replacement. Similarly, compensation is reduced if functionality can be maintained by replacing only part of a system.

### **The Base Case**

Consider an incumbent ENG or fixed link microwave spectrum user that must be displaced to accommodate MSS providers. Assume that

- the incumbent's equipment was purchased  $m$  years before the reassignment occurs;
- the total useful life of old equipment is  $n$  years, i.e., its remaining useful life at the time of reassignment is  $(n-m)$  years;
- old equipment cannot be used at the frequencies to which the incumbent is reassigned, i.e., it must be scrapped;
- the prices, useful lives, and functionalities<sup>28</sup> of old equipment and the equipment that is used at the new frequency are the same; and
- the market value of equipment declines in proportion to the number of years it has been used, i.e., its market value at the time of the reassignment is its original cost multiplied by  $(n-m)/n$ .

In these circumstances, the principle of making the incumbent neither better nor worse off as a result of the frequency reassignment results in compensation equal to the

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<sup>28</sup> The FCC has identified the key elements to determine whether a facility is functionally equivalent when incumbents are relocated as throughput, system reliability, and operating cost. See Cost Sharing First R&O/Further NOPR, Paras. 25-32.

original equipment cost multiplied by  $(n-m)/n$ , the value of the remaining life of the equipment.<sup>29</sup> Thus, for example, if equipment with a useful life of 20 years were scrapped after 5 years of use, compensation would be  $(20-5)/20$ , or 75%, of its original cost. The incumbent would pay 25% of the cost since the new equipment would last 5 years longer than the equipment it replaced.

If, instead, the incumbent were to receive compensation equal to the full cost of new equipment, as under the Commission's proposal, he would receive a windfall equal to the cost of equipment multiplied by  $m/n$  or, in the example, 25% of original cost. Put slightly differently, just compensation requires that the incumbent *not* receive compensation for the decline in value of the equipment since it was purchased.<sup>30</sup> As the CRS report cited above indicates, the courts have generally been averse to employing the cost-of-substitute-facilities standard, precisely because it would result in windfalls for the incumbent in these circumstances.<sup>31</sup>

As Justice White's concurring opinion emphasizes, the incumbent should contribute something toward the cost of new equipment if that equipment will last longer than the equipment that is displaced. This means that the remaining service life of the incumbent's equipment needs to be taken into account in determining the amount of compensation that would make him "whole." Suppose, at one extreme, that the

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<sup>29</sup> It is mathematically equivalent to state this criterion in terms of replacement costs, as the FCC did. The incumbent receives replacement cost minus the proportion of the cost that has been used up. If original and replacement costs are identical,

$$\text{Compensation} = (n-m)/n \times \text{Replacement Cost} = \text{Replacement Cost} - (m/n) \times \text{Original Cost}.$$

In the general formula presented below, we allow for differences between original and replacement cost.

<sup>30</sup> This is the principle enunciated by Professor Epstein, *op. cit.*, as well.

<sup>31</sup> CRS Report, Section 9.5.

incumbent is being relocated at almost exactly the time that he would have had to replace his equipment if he continued to operate at his present frequency assignment. In that case, the incumbent will be no worse off if, instead of purchasing equipment that operates at the present frequency, he must purchase equipment that costs the same, and has the same functionality, but that can operate at his new frequency assignment. *In this case, no compensation is required to leave the incumbent in the same position as he was before being displaced.*

At the other extreme, suppose that the incumbent has just purchased and installed new equipment and then is required to move to a different frequency where the equipment he has just purchased cannot operate. If the equipment that has just been purchased has no salvage value, and if all of the other assumptions made above hold, the incumbent can be made whole only by paying him compensation equal to the price of the equipment he has just purchased.

In general, the incumbent will have obtained some use from the existing equipment, but it will not have reached the end of its useful life. Thus, in general, the incumbent is made whole by receiving compensation equal to the value of the *remaining* useful life of his existing equipment. If the FCC were to require entrants to pay incumbents more than this amount, it would violate its stated goal of making incumbents neither better nor worse off.<sup>32</sup>

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<sup>32</sup> As we note below, even if the frequency assignment occurs immediately after the old equipment has been purchased, cost sharing will be required if the new equipment has greater functionality than the old. Note that the problem of possible overcompensation being discussed here is separate and apart from the fact that incumbents have incentives to overstate the costs and difficulties of operating at the new frequency, and in fact to incur excessive costs, if they are receiving compensation based on those costs.

To summarize, cost sharing by the incumbent is not required only if existing equipment must be scrapped immediately after it is put in service. By contrast, the Commission's proposed compensation formula would not require cost sharing in any case, even where old equipment otherwise would need immediate replacement.

### **Inflation in the Price of Old Equipment**

Consider the case in which all of the other assumptions made above still hold but that the price of equipment has increased since the incumbent purchased his equipment.<sup>33</sup> Since the price of new equipment is higher than the original price of old equipment, the compensation formula must take that fact into account. That is achieved by providing compensation equal to the market value of the old equipment at the time of the reassignment,<sup>34</sup> which reflects both the increase in equipment prices and the fact that the new equipment will last longer than the old. If the cost of equipment in our example has increased since the original purchase, just compensation would equal 75% of the new higher price.<sup>35</sup> Although the price of equipment has increased, which increases the appropriate amount of compensation, the incumbent must, nonetheless, share in its cost in order to account for its longer life.

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<sup>33</sup> We abstract from any improvements in the quality of equipment that may account for the price rise. To be precise, when we speak of price increases we mean price increases adjusted for quality changes. On the need to adjust for quality changes in assessing price changes, see Z. Griliches, "Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality Change," Government Price Statistics, Hearings, U.S. Congress, Joint Economic Committee, January 24, 1961.

<sup>34</sup> This is an example of the principle enunciated by Epstein, and endorsed by the Courts, that incumbents must be compensated for any appreciation or depreciation in the price of old equipment since its purchase.

<sup>35</sup> Recall that improvements in the quality of equipment must be taken into account in determining whether prices have increased.



## Cost Adjustments Due to Operation at a New Frequency

The adjustments discussed to this point reflect changes in the price or functionality of existing equipment. When the incumbent is required to operate at a new frequency, there may be additional costs, or savings, associated with the new assignment. For the moment, we will assume that the *amount* of equipment needed to operate at the new frequency remains the same, but that the cost of equipment must be scaled either up or down to reflect any cost differences. In the general compensation formula described below, this adjustment is represented as  $(1+\lambda)$ , where  $\lambda > 0$  represents higher costs of operating at the new frequency.<sup>36</sup>

Cost differences can arise from three sources: (a) equipment used at the new frequency has different component costs; (b) equipment used at the new frequency has different functionality; and/or (c) equipment used at the new frequency has different operating costs.

Equipment Used at the New Frequency is More Expensive. Suppose, as in the base case, that the market value of old equipment has declined in proportion to the number of years it has been used but now assume that equipment needed to operate in the newly assigned frequency is more expensive than, but has the same functionality as, equipment used at the original frequencies. Here, in order to provide the appropriate amount of compensation, the incumbent must receive an amount equal to the price of the equipment needed to operate at the new frequency minus the value of its additional useful life.

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<sup>36</sup> Below, we discuss the case in which additional equipment may be needed, which requires an *adder* to the general compensation formula.

Although this may appear to violate the point made above that compensation should ignore the cost of substitute facilities, taking the higher cost of equipment used at the new frequency into account is required to keep the incumbent from being made worse off *if* this equipment has the same functionality as the equipment previously used *and if* the incumbent's best alternative is to move to and operate at the newly-assigned frequencies. The apparent contradiction can be resolved by noting that all equipment of the same age and functionality would sell for the same price. Thus, the introduction of more expensive equipment would raise the market price of old equipment and compensation should be paid on the basis of this new higher value.<sup>37</sup> Of course, the amount of compensation is less than the cost of the new equipment to reflect its longer remaining useful life.

Equipment Used at the New Frequency Has Greater Functionality. The required amount of compensation must be reduced if equipment used at the new frequency has greater functionality than the equipment it replaces. Again, the way to think about this is to note that a smaller amount of new equipment is required to produce the same output as was produced by the old equipment. Alternatively, the greater functionality of the new equipment lowers the market value of the old, and compensation should be equal to the (correctly calculated) market value of the old equipment. Of course, compensation must also be reduced to take into account the fact that the replacement

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<sup>37</sup> Of course, the incumbent may simply pocket the compensation if it is uneconomic to operate at the newly assigned frequency. Another way to view the point made in the text is to note that incumbents are being deprived of both their old equipment and their license to operate that equipment at the old frequency. The differences in the value of the licenses to use the new and old frequencies will reflect any differences in the costs of the equipment used at those frequencies.

equipment is newer, and thus has a longer remaining useful life, than the equipment it replaces.<sup>38</sup>

Adjusting for Differences in Operating Costs. Beyond differences in the purchase price of equipment used to operate at different frequencies, other costs may also differ. For example, operation and maintenance costs may be either higher or lower at the new assigned frequency. If this is the case, the amount of compensation should be adjusted to reflect this difference. This difference can be included in the term  $(1+\lambda)$  by recognizing that differences in the present value of operating costs can be treated in the same manner as differences in equipment purchase costs. Technical experts have informed us that differences in the operating costs incurred by the displaced incumbents at different frequencies will, in general, be small, if not negligible.

### **The General Formula**

The previous discussion shows that the general formula for compensating the incumbent is

Compensation =  $C ((n-m)/n) (1+p-r)^m (1+\lambda)$ , where

C is the original cost of equipment;

n is the original useful life of equipment;

m is the number of years equipment has been in service;

p is the annual rate of increase in equipment prices;

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<sup>38</sup> Even if the equipment used at the newly assigned frequency is less expensive on a quality-adjusted basis than the equipment used at the original frequency, the alternative of moving to the new frequency was presumably unavailable prior to the frequency reassignment.

$r$  is the annual rate of equipment productivity improvement; and

$\lambda$  is the cost penalty ( $1+\lambda>1$ ) or benefit ( $1+\lambda<1$ ) of moving to the new band.

If  $p$ ,  $r$ , and  $\lambda$  are all zero, compensation should equal the proportion of the original useful life of old equipment that remains times the original cost of that equipment. This is the base case discussed above.

If the equipment were due to be replaced just prior to the frequency relocation, compensation would be zero. Note that the term  $(n-m)/n$  in the compensation formula would be zero in this case. If the equipment were newly purchased, the term  $(n-m)/n$  would be 1, and compensation would equal its purchase price.

If the (quality-adjusted) price of old equipment has increased between the time of its purchase and the time of the spectrum reassignment, i.e., if  $(p-r) > 1$ , compensation should be increased to reflect that fact. Conversely, if quality-adjusted prices have fallen, i.e., if  $(p-r) < 1$ , compensation should be reduced below that in the base case.

Similarly, if the equipment needed to operate at the new frequency is more expensive (on a quality-adjusted basis) than the equipment it displaces, or if operating costs at the new frequency are higher than at the old, the term  $(1+\lambda)$  would be greater than 1. In either of these cases, the amount of compensation needed to make the incumbent no worse off is increased.<sup>39</sup> In effect, we assign a higher market value to equipment operating at the present frequency because of the higher costs of operating

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<sup>39</sup> However, if, for example, equipment costs have fallen greatly and operating costs are only slightly higher at the new frequency, the net effect is to reduce the amount of compensation.

at the new frequency. Equivalently, this implies that the value of the license to operate at the original frequencies has increased.

### **The Treatment of Additional Equipment**

The previous discussion implicitly assumed that the amount of equipment used by the incumbent remains the same while the particular equipment used changes. However, if the incumbent must employ additional equipment, the price of that equipment must be included in the compensation that is paid if the incumbent is to be made indifferent between the old and new situations.<sup>40</sup>

### **APPLYING THE COMPENSATION FORMULA TO THE SPECIFIC CASE OF MSS SPECTRUM**

In the specific case we are considering, the FCC (and the Congress) have determined that a portion of the spectrum should be allocated to use by Mobile Satellite Service (MSS), thus requiring current users to be relocated to another portion of the spectrum. MSS users require frequency assignments for both uplink (earth-to-sky) and downlink (sky-to-earth).

Under the Commission's proposal, the 120 MHz in the 2 GHz band currently assigned to Broadcast Auxiliary Service (BAS) for Electronic NewsGathering (ENG) and other services will be divided into two parts. One part will be assigned for BAS use and the remainder will be assigned to MSS use for uplinks. Since it is anticipated that BAS operations will interfere with MSS uplink operations at these frequencies, BAS operations will be moved out of the 35 MHz comprising the MSS uplink band (1990 -

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<sup>40</sup> As above, there is the danger that the incumbent may choose not to operate at the new frequency, in which case this approach leaves him better off than he was before the reassignment.

2025 MHz). The FCC has assigned 35 MHz in the 2 GHz band for use by MSS for downlink. This portion of the spectrum is currently assigned to fixed segment terrestrial microwave users. If there is significant interference when MSS operates at these frequencies, these users will be relocated to higher frequencies.<sup>41</sup>

A number of features of current and proposed operation by incumbents, as well as the equipment they use, help to determine the appropriate amount of compensation for displaced incumbents. Current equipment varies both in its age and, in some cases, the technology that it employs. At one extreme, some equipment may have been installed many years ago using earlier technologies and is nearing the end of its useful service life. At the other extreme, digital equipment incorporating the latest technical advances in integrated chipsets may have recently been purchased.

One implication of these differences in vintage and technologies is that relocation costs may vary from one incumbent to another, possibly by very large amounts. Indeed, some equipment may be “frequency agile” and the costs of changes to operate at another frequency will be modest. Other equipment may require larger investments in labor and equipment to change frequency. Yet other equipment may be too expensive to change for use at another frequency and it will be more economical to replace it with new equipment.

### **Compensation for BAS Incumbents**

Technical experts have informed us that in the case of equipment used for BAS, the most recent vintage incorporates digital tuning using reprogrammable EPROMs and

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<sup>41</sup> As in the BAS relocation, the precise frequency assignments do not affect the general applicability of the compensation formula, although they may affect the amount of compensation that is appropriate.

is frequency agile. Thus, it can be retuned to operate at new channel assignments for a modest cost.<sup>42</sup> This cost is the appropriate amount of compensation for displaced incumbents using the newest equipment.

We understand that the older BAS equipment either operates at fixed frequencies or has limited availability of replacement parts and, in many cases, cannot economically be converted to operate at the new channel assignment. As a result, some or all of its components would have to be replaced. However, this equipment is probably nearing the end of its useful service life and would have to be replaced soon in any event. For this reason, incumbents should be compensated only for a relatively small fraction of the cost of the new equipment that they must purchase as a result of the frequency relocation.<sup>43</sup> In order to prevent the windfall gains that the courts seek to avoid, component replacement should be required when its cost is lower than the cost of replacing an entire system.<sup>44</sup>

### **Compensation for Fixed Link Microwave Incumbents**

Fixed link microwave incumbents will be relocated to other frequencies if there is harmful interference from MSS entrants. We understand from technical experts that existing transmitter equipment is generally not able to function at the new frequencies but that the existing microwave towers can continue to be used. The general compensation formula accommodates this circumstance by taking account of the

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<sup>42</sup> Other possible modest modifications to the most recent vintage equipment may entail replacement of the receiver IF filter to accommodate the reduced channel bandwidth.

<sup>43</sup> We understand from technical experts that, roughly speaking, tuners using reprogrammable EPROMs for tuning were introduced 10 to 12 years ago; earlier equipment used non-digital tuners.

quality-adjusted changes in equipment costs, including any cost penalty (or benefit) from operating at the new frequency assignment, adjusted for the remaining number of years of useful service life of the equipment that is being replaced.

We also understand that, in some instances, operating at the new frequencies affects the distance over which the microwave link can operate for a given level of service quality. As a result, operating at these higher frequencies may require additional towers, along with the equipment placed on those towers. The just compensation formula, intended to ensure that incumbents are made no worse off, requires that the entrant pay the cost of any additional towers and equipment.<sup>45</sup>

### **Administrative Feasibility**

The general formula for just compensation can be administered in a straightforward manner using information that should be available in any particular situation. It represents a practical means of assuring adequate compensation without creating an undue burden for information or administration. However, in some circumstances, the Commission may be able to adopt an even simpler calculation.

We understand from technical experts that prices for BAS equipment have generally stayed the same or have fallen in real (inflation-adjusted) terms for a given

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<sup>44</sup> If the new components must be scrapped when the remainder of the system reaches the end of its *useful* life, one should not take into account their longer *physical* lives in determining the appropriate amount of compensation.

<sup>45</sup> Suppose, for example, that a two-tower microwave link can operate at the current frequency, but that an intermediate tower, with associated equipment, is needed at the higher-frequency assignment. In that circumstance, the just compensation formula would provide a fraction of the costs of new equipment used at the two existing towers and all of the costs of constructing the intermediate tower, including the costs of obtaining any necessary permits and any associated equipment.



level of functionality, and that functionality generally appears to have stayed the same or to have improved with the more recent technology.<sup>46</sup>

In these circumstances, compensation can be based simply on original equipment cost and the remaining fraction of that equipment's original service life. Specifically, the assumptions are that:

- the useful life of new equipment is at least as great as the useful life of old equipment when it was purchased;
- the functionality of new equipment is at least as great as that of old equipment;
- the quality-adjusted price of (new) old equipment has not changed over time;
- the price of new equipment is no greater than that of (new) old equipment; and
- no additional equipment must be purchased to operate at the new frequency.

In this case, just compensation requires paying the incumbents no more than the value of the remaining useful life of their existing equipment. This approach guarantees that the incumbent will receive an amount *greater than or equal to* the value of his current equipment. Indeed, if the quality-adjusted price of equipment has declined greatly, the incumbent would be significantly *overcompensated*. In this case, entrants may wish to submit facts to justify an even lower level of compensation.<sup>47</sup>

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<sup>46</sup> For example, newer equipment utilizes surface mount technology, has an improved noise figure, and higher signal-to-noise, and includes features such as a color bar generator for calibration, video presence detection, and multiband operation.

<sup>47</sup> Technical experts inform us that, in the case of terrestrial microwave equipment, functionality (measured by number of voice channels that can be carried, as well as reliability and fault tolerance) seems to have increased significantly with the use of digital transmission. The throughput of digital equipment with signal compression may be several times greater than the analog equipment that it replaces.

## CONCLUSION

The Commission has articulated the principle of compensating incumbents to the point where they are no worse off if they are required to relocate. This principle can be implemented in a practical, relatively simple manner that is fair to both incumbents and entrants. Nevertheless, contrary to the Commission's proposal, we find that it is inappropriate to make compensation equal to the full replacement cost of equipment. Instead, incumbents should be required to share in the cost of new equipment in all but very rare circumstances.

Specifically, the incumbent should receive compensation that equals the (correctly calculated) market value of any equipment that must be replaced plus the cost, if any, of additional equipment that is required to operate at the new frequency. If, as we have been informed, replacement equipment often (a) costs the same or less than the equipment it replaces, (b) has the same or better functionality, and (c) lasts as long or longer than the equipment it replaces, then the general formula for compensation always is more generous than is needed to make the incumbents no worse off. Thus, the Commission can adopt a very simple formula for determining compensation in cases in which the parties fail to reach voluntary agreements: compensation should equal original equipment costs multiplied by the remaining fraction of the equipment's useful life. This will serve to compensate the incumbent for the value of the remaining service life of the equipment that must be replaced as a result of the forced relocation. Of course, at their option, entrants should always be allowed to pay the cost of modifying existing equipment to operate in the new frequency if that option is more economical and meets the requirement for functional equivalence.

# **APPENDIX**

Resumes of  
Jan Paul Acton  
and  
Stanley M. Besen

## JAN PAUL ACTON – Vice President

### EDUCATION

Ph.D. Economics, Harvard University  
A.M. Economics, Harvard University  
B.A. *With Highest Honors, Economics With Distinction*, San Diego State College

### PROFESSIONAL EXPERIENCE

- 1999 – Present *Vice President*, Charles River Associates, Washington, D.C. Dr. Acton specializes in the economics of energy and natural resources, telecommunications, regulated industries, industrial organization and deregulation, health economics, and financial institutions. He is a recognized expert witness on electricity and gas pricing issues and has appeared before regulatory bodies in the United States and Canada. He has testified on numerous occasions before committees of the U.S. Congress on such topics as automated teller machine surcharging, trade legislation, oil reserve policy, and the effects of royalty programs for hard rock mining, as well as on several environmental policy issues.
- 1991 – 1999 *Assistant Director*, the U.S. Congressional Budget Office, heading the Natural Resource and Commerce Division. The Division deals with issues in energy, environment, agriculture, international trade, financial institutions, industrial organization, infrastructure, and science and R&D policy. The Division also prepares CBO's private sector cost statements under the Unfunded Mandates Reform Act of 1995 in these subject areas. Dr. Acton's responsibilities included developing a study agenda for the Division, supervising and reviewing studies and reports prepared for the Congress, briefing staff and members of Congress, and delivering testimony at Congressional hearings.
- 1989 – 1991 *Member*, The RAND Graduate School faculty, teaching microeconomic theory in Ph.D. policy analysis program.
- 1989 – 1991 *Co-Editor*, *The RAND Journal of Economics*.
- 1983 – 1991 *Director*, Regulatory Policies Program, The RAND Corporation, Santa Monica, California. Responsible for program development and guidance on topics affected by governmental regulatory, tax, and trade policies. The work included pricing and franchise policies for traditionally regulated industries – including the interest in deregulating many of these activities; environmental, health, and safety regulation – including risk assessment and evaluation of mortality, morbidity, and aesthetic effects; and industry structure and



performance – especially in light of governmental tax, regulatory, antitrust, and trade policies. Cross-cutting themes in this work include the evaluation of non-monetary impacts of governmental programs and policies; analysis of the distribution of impacts across individuals and groups; and analysis of governmental policies when multiple jurisdictions and overlapping policies are involved.

1970 – 1991     *Senior Economist*, Economics Department, The RAND Corporation, Santa Monica, California. Dr. Acton's research fields included environmental economics, the economics of energy and natural resources, industrial organization and regulated industries, health economics, and benefit/cost analysis and public finance.

## RESEARCH AREAS

**Environmental Policy.** Dr. Acton has analyzed the effects of government environmental policies, especially those dealing with hazardous waste. His work has examined the effects of having selected a liability-based system on the pace, cost, and efficiency of cleaning at closed and abandoned hazardous waste sites. This project was based on original data collected from the EPA, private industry, and insurers. In addition, Dr. Acton reviewed DoD's environmental programs and developed an analytic framework to identify tradeoffs among environmental priorities.

**Industrial Organization and Deregulation.** Dr. Acton's work in these areas has focused on the energy and telecommunications sectors. He was co-director of a project to examine the effects of relaxed regulation of Bulk Power Exchanges among U.S. electric utilities. This work for the Federal Energy Regulatory Commission included advice on the design of a bulk power market experiment; identification of data to be collected before and during the experiment; and analysis of both the competitiveness of the resulting market and the effects on economic efficiency for utilities, customers, and shareholders.

Dr. Acton has also conducted research on international telecommunications demand. In a major project, he examined inbound and outbound long-distance calling patterns between the U.S. and 18 Western European countries, emphasizing different elements of the rate structure. The implications for balance of payments and other effects were also studied.

Dr. Acton was also co-director of a project supported by the National Science Foundation to examine pricing policies for a regulated industry in the face of conflicting evidence of response. Regulators often receive contradictory statistical evidence, which could lead to inconsistent policy recommendations (apply new rates broadly versus apply on a very limited basis). Sometimes the differences are due to underlying data, but sometimes to the statistical models employed. Dr. Acton examined these discrepancies in the context of several different electricity usage datasets and submitted his own methodological and policy recommendations.



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Dr. Acton served as a consultant to the Treasury Department, Government of New Zealand, regarding the creation of a state-owned enterprise in electricity. The issues included asset valuation, creation of one or more supply authorities, provision for allowing competitive supply, and review of regulations that may or may not be needed to meet public goals. Dr. Acton prepared a report to Treasury at the time that body was preparing to transfer responsibility for electricity supply from the Energy Department to the new enterprise.

**Energy and Natural Resources.** Dr. Acton has conducted research, prepared expert testimony, and published in academic journals on several aspects of the demand for energy and natural resources, as well as the appropriate methods for determining costs of service and suitable rate structures. He has examined econometrically the demand for alternative forms of energy under a variety of pricing structures.

Dr. Acton has led projects that analyzed, from a national perspective, the implications of marginal cost pricing for rate design and electricity demand. That work considered in particular the transferability of rate experiment results to different parts of the country and evaluated the consequences for different groups of customers. The project also examined ongoing U.S. experience with time-of-use pricing applied to larger commercial and industrial customers on a non-experimental basis. A third aspect considered electricity rate design using actual estimates of marginal costs and consumer price responsiveness and then assessed, among other factors, the benefits of optional versus mandatory rates.

Dr. Acton was co-principal investigator of the Los Angeles Electricity Rate Study, a major five-year social experiment to measure the costs and benefits of peak-load pricing of electricity. The study included 2,000 households assigned to one of 40 different experimental rates. He also directed work on the demand for energy and distribution of consequences under conventional rate structures and under a mandatory curtailment ordinance that was enacted in Los Angeles following the Arab oil embargo of 1973–74. He participated in a review of pricing policies in six Western European countries to determine the principles of peak-load pricing from the point of view of large industrial commercial customers in European countries. He served for three years as a *pro bono* member of the Mayor's Committee on Water and Power Rates in Los Angeles and was instrumental in designing a comprehensive restructuring of electricity rates based on marginal cost principles and applied on a time-of-day basis to the 750 largest customers in the Los Angeles system. The Committee also reviewed the basis for determining the cost of water supply and recommended changes in L.A. water rates. The Committee's recommendations were adopted unanimously by the Board of Water and Power Commissioners and by a 12-3 vote of the L.A. City Council. Dr. Acton has testified before the California Public Utilities Commission, the U.S. Congress, the Ontario (Canada) Energy Board, the British Columbia Utilities Commission, and the boards of directors of several publicly controlled utility systems.

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**Health.** Dr. Acton has conducted research on the determinants of demand for inpatient and ambulatory medical services under present payment mechanisms and under alternative National Health Insurance proposals. His research concentrated especially on the effects of non-monetary factors – such as travel time and waiting time – on the demand for care. Some of his earlier work at RAND included a study of principles of health manpower training and the consequent planning problem for a state planning agency, as well as a project applying the principles of decisionmaking under uncertainty to patient management. Before starting full-time work in November 1970, Dr. Acton was a consultant to RAND, and during the summer of 1969 was part of a study on the effectiveness of coronary care units.

**Public Expenditure Analysis.** Dr. Acton led a team developing a framework for the evaluation of the social effects of health research for heart, lung, and blood diseases, including a measure of individual assessments of these impacts. His Ph.D. thesis, *Evaluation of a Life-Saving Program: The Case of Heart Attacks* (Thesis Committee: Martin S. Feldstein, Howard Raiffa, and Thomas Schelling), considered five proposals for treating victims of a heart attack. He assessed the expected effectiveness of several untried technologies and considered optimal strategies in the face of uncertainty. Dr. Acton also analyzed several measures for valuing the lives that might be saved and conducted a survey measuring people's willingness to pay for reduction in probability of death.

**APPEARANCES BEFORE GOVERNMENTAL BODIES AND EXPERT TESTIMONY**

**Testimony Before Governmental and Legislative Bodies**

- Before: The Committee on Banking, Housing, and Urban Affairs, United States Senate, hearings to discuss automated teller machine fees, July 15, 1998.
- Before: The Committee on International Relations, House of Representatives, hearings to discuss domestic costs of sanctions on foreign commerce, June 3, 1998.
- Before: The Subcommittee on Energy and Power, Committee on Commerce, House of Representatives, hearings to discuss the appropriate use of the Strategic Petroleum Reserve, May 8, 1996.
- Before: The Subcommittee on Trade, Committee on Ways and Means, House of Representatives, hearings to discuss proposed Antidumping Regulations, April 23, 1996.
- Before: The Subcommittee on Water Resources and Environment, Committee on Transportation and Infrastructure, House of Representatives, hearings to discuss the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, June 22, 1995.



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- Before: The Subcommittee on Superfund, Waste Control, and Risk Assessment, Committee on Environment and Public Works, United States Senate, hearings to discuss the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), April 27, 1995.
- Before: The Subcommittee on Trade, Committee on Ways and Means, House of Representatives, hearings to discuss the results of the CBO's study *A Budgetary and Economic Analysis of the North American Free Trade Agreement*, September 21, 1993.
- Before: The Subcommittee on Mineral Resources Development and Production, Committee on Energy and Natural Resources, United States Senate, hearings on Reforms of the Mining Law of 1872, May 4, 1993.
- Before: The Subcommittee on Transportation and Hazardous Materials, Committee on Energy and Commerce, U.S. House of Representatives, hearings on the Superfund Cleanup Program, April 21, 1993.
- Before: The Subcommittee on Mineral Resources Development and Production, Committee on Energy and Natural Resources, United States Senate, hearings on Reforms of the Mining Law of 1872, March 16, 1993.
- Before: The Subcommittee on Oversight, Committee on Ways and Means, U.S. House of Representatives, hearings on the Superfund Cleanup Program, June 11, 1992.
- Before: The Council of Scientific Society Presidents, The Budgetary Environment for Science Priorities, December 9, 1991.
- Before: The Subcommittee of Investigations and Oversight of the Committee on Public Works and Transportation, U.S. House of Representatives, hearings on Review of the Superfund Program, CERCLA, October 29, 1991.
- Before: The Water and Power Committee and before the City Council, City of Los Angeles, multiple appearances on restructuring water and power rates, on behalf of the Mayor's Committee on Water and Power Rate Structures, Fall 1977.
- Before: The Subcommittee on Energy and Power of the Committee on Interstate and Foreign Commerce, U.S. House of Representatives, hearings on the National Energy Act (HR 6660), at the invitation of the Subcommittee Staff, May 23, 1977 (pp. 903-943).

**Expert Testimony on Electricity Matters**

- Before: The British Columbia Utilities Commission in the matter of West Kootenay Power and Light's 1984 Rate Application, December 1-2, 1983, on behalf of the Consumers' Association of Canada (BC Branch), the Federated Anti-Poverty Groups of





**JAN PAUL ACTON – Page 6**

B.C., the Sierra Club of Western Canada, and the B.C. Old Age Pensioners' Organization.

- Before: The California Public Utilities Commission, in the matter of Pacific Gas and Electric Company's general rate application (Application No. 82-12-48) on behalf of the Local Government Commission on Conservation and Renewable Resources, May 17 and July 5, 1983.
- Before: The British Columbia Utilities Commission, in the matter of British Columbia Hydro and Power Authority, general rate case, October 19, 1982, on behalf of the Consumers' Association of Canada (BC Branch), the Federated Anti-Poverty Groups of B.C., the Sierra Club of Western Canada, and the B.C. Old Age Pensioners' Organization.
- Before: The California Public Utilities Commission, in the matter of Pacific Gas and Electric Company's general rate case (Application Nos. 60153 and 60616), on behalf of Contra Costa County, May 12, 1982.
- Before: The Tennessee Valley Authority, Board of Directors, in the matter of their PURPA hearings, at the invitation of the TVA staff, May 10, 1982.
- Before: The Board of Water and Power Commissioners, Los Angeles Department of Water and Power, on electricity demand and pricing considerations, at the invitation of the Board and/or staff, numerous appearances between 1975 and 1980.
- Before: The Sacramento Municipal Utility District's Board of Directors, in the matter of their PURPA hearings, on behalf of the Environmental Council of Sacramento, October 9, 1979.
- Before: The Ontario Energy Board (Canada), in the matter of Ontario Hydro (a generic electricity rate case), on behalf of the National Anti-Poverty Organization of Canada, January 30-31, 1979.
- Before: The California Public Utilities Commission, Case 9804 (generic electricity rate case for all utilities, including time-of-day and marginal cost pricing), at the invitation of Commissioner Leonard Ross, Spring 1975.

**CONSULTANCIES**

Treasury Department, Government of New Zealand  
Local Government Commission on Conservation and Renewable Resources  
The Board of Supervisors, Contra Costa County (California)  
Mayor's Blue Ribbon Committee on Water and Power Rates (Los Angeles)



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The National Center for Health Services Research and Development  
(Economic Analysis Branch and Health Care Technology Division)  
The National Institute of Mental Health (Planning Branch)  
The National Institute of Health  
The Environmental Protection Agency  
The California State Department of Public Health  
National Academy of Sciences  
Public Interest Advocacy Centre (Ontario, Canada)  
The Environmental Council of Sacramento  
The Electric Power Research Institute  
Public Interest Advocacy Centre (British Columbia, Canada)

**PROFESSIONAL ORGANIZATIONS/HONORS**

Harvard Graduate Prize Fellowship in Economics (four years)  
Woodrow Wilson Fellowship  
U.S. Public Health Service Scholarship for Research Training in Medical Care  
Carnegie Foundation Research Fellowship in Health Economics  
American Economics Association  
Royal Economic Society  
Member, Editorial Board, *Health Policy Quarterly*  
Member, Editorial Board, *Journal of Business Administration*  
Reviewer for several economic journals  
San Diego State University Alumnus of the Year, College of Arts and Letters, 1983

**PUBLICATIONS**

**Book**

*Peak-Load Pricing: European Lessons for U.S. Energy Policy* (Cambridge, MA: Ballinger Publishing Co., 1978) (coauthored).

**Book Chapters**

“Electricity Consumption by Time of Use in a Hybrid Demand System,” in Jorg Finsinger (ed.), *Public Sector Economics*, London: Macmillan, 1983, pp. 27-64 (coauthored).

“Welfare Analysis of Electricity Rate Changes,” in S. Berg (ed.), *Metering for Innovative Rate Structures*, Lexington Press, 1983, pp. 195-225; also The RAND Corporation, N-2010-HF/FF/NSF, May 1983 (coauthored).



“The Tradeoff Between Equity and Efficiency in Electric Utility Rate Structures: A Comment on the TVA Approach,” in Hans H. Landsberg (ed.), *High Energy Costs: Assessing the Burden*, The Johns Hopkins University Press, 1982, pp. 160-169; also The RAND Corporation, N-2009-HF/FF/NSF, May 1983.

“Electricity Consumption by Time-of-Use in a Hybrid Demand System,” *Analysis Forecasting and Planning for Public Utilities: Vol. 1, Economic Analysis*, Fontainebleau, France, 1980, pp. 198-257; also The RAND Corporation, R-2628-DWP/HF, December 1980 (coauthored).

“Evaluating Time-of-Day Electricity Rates for Residential Customers: Preliminary Los Angeles Results,” in Mitchell and Kleindorfer, *Regulated Industries and Public Enterprise: European and United States Perspectives*, Lexington Books, 1980; also The RAND Corporation, R-2509-DWP, November 1979 (coauthored).

“Lessons from the Los Angeles Rate Experiment in Electricity,” in John L. O’Donnell (ed.), *Adapting Regulation to Shortages, Curtailment and Inflation*, Michigan State University Public Utilities Studies, East Lansing, Michigan, 1977; also *Lessons to Be Learned from the Los Angeles Rate Experiment in Electricity*, The RAND Corporation, R-2113-DWP, July 1978 (coauthored).

“Peak-Load Pricing in Selected European Electric Utilities,” in Anthony Laurence (ed.), *Time of Day and Seasonal Modeling*, Electric Power Research Institute, December 1977; also The RAND Corporation, R-2031-DWP, July 1977 (coauthored).

“Demand for Health Care Among the Urban Poor, with Special Emphasis on the Role of Time,” in Richard Rossett (ed.), *The Role of Health Insurance in the Health Services Sector*, National Bureau of Economic Research, New York, 1976; also The RAND Corporation, R-1151-OEO/NYC, April 1973.

“Compulsory Health Planning Laws and National Health Insurance,” in Clark Haighurst (ed.), *Health Planning, Certificates of Need, and Market Entry*, American Enterprise Institute, Washington, D.C., 1973 (coauthored).

“Manpower and Facilities Requirements Analysis: A Critique,” in *Towards a Systematic Analysis of Health Care in the United States*, A Report to the Congress by the Secretary of HEW, October 1972.

## Published Articles

“Telephone Demand Over the Atlantic: Evidence from Country-Pair Data,” with Ingo Vogelsang, *Journal of Industrial Economics*, Vol XL, No. 3, September 1992, pp. 305-23.

“Introduction to Price Cap Papers,” with Ingo Vogelsang, *The RAND Journal of Economics*, Vol. 20, No. 3, Autumn 1989, pp. 369-72.



“Assessing the Effects of Bulk Power Rate Regulation: Results from a Market Experiment,” with Stan Besen, *Applied Economics*, Vol. 19, No. 5, May 1987, pp. 663-686.

“Response to TOD Electricity Rates: What Should the Regulator Do in the Face of Conflicting Evidence?”, with Ed Park, *Proceedings of the Sixth International Symposium on Forecasting*, Paris, June 1986.

“Large Business Customer Response to Time-of-Day Electricity Rates,” *Journal of Econometrics*, Vol. 26, Nos. 1/2, Annals 1984-3, pp. 229-252 (coauthored).

“The Effect of Rates on the Pattern of Industrial Electricity Consumption,” *Journal of Business Administration*, Vol. 14, 1983/84, 1984, pp. 41-70 (coauthored).

*Industrial Response to Time-of-Use Rates: Quantitative Analysis of French, English, and Welsh Data*, monograph EA-3506, Electric Power Research Institute, Palo Alto, California, May 1984; also The RAND Corporation, R-3010-EPRI/HF/RC.

“Competition Could Trim Consumers’ Electricity Bills,” editorial page, *The Los Angeles Times*, April 26, 1982.

“An Evaluation of Economists’ Influence on Electricity Utility Rate Reforms,” *American Economic Review, Proceedings*, Vol. 72, No. 2, May 1982, pp. 114-119; also The RAND Corporation, P-6726, January 1982.

“Letter to the Editor,” *Public Utilities Fortnightly*, Vol. 108, No. 6, p. 8, September 10, 1981 (coauthored).

“The Effects of Time-of-Use Rates: Facts versus Opinions,” *Public Utilities Fortnightly*, Vol. 107, No. 9, pp. 19-25, April 23, 1981; also The RAND Corporation, R-2760-HF/FF/NSF.

“Seasonal Electricity Demand: A Variable Response Model,” *The Bell Journal of Economics*, Vol. 12, No. 11, pp. 71-82, Spring 1981; also The RAND Corporation, R-2425-DWP, May 1980 (coauthored).

“Estimating Residential Electricity Demand under Declining Block Tariffs: An Econometric Study Using Micro-Data,” *Applied Economics*, Vol. 12, No. 2, June 1980, pp. 145-162, March 1980; also The RAND Corporation, P-6203, November 1978 (coauthored).

“The Effect of Time-of-Day Rates in the Los Angeles Electricity Study,” *Electric Rate Demonstration Conference, Papers and Proceedings*, U.S. Department of Energy, 1980, pp. 212-27; also The RAND Corporation, N-1533-DWP/HF, June 1980 (coauthored).



“Planning, Processing, and Analyzing Data for Residential Load Studies,” *Electric Rate Demonstration Conference, Papers and Proceedings*, U.S. Department of Energy, 1980, pp. 137-51; also The RAND Corporation, N-1534-DWP, June 1980 (coauthored).

“Do Time-of-Use Rates Change Load Curves? And How Would You Know?,” *Public Utilities Fortnightly*, Vol. 105, No. 11, pp. 15-24, May 1980; also The RAND Corporation, R-2588-DWP/EPRI, May 1980 (coauthored).

“Electricity Prices and the Poor: What Are the Effects and What Can We Do?,” *Report from Symposium on Energy Pricing and the Poor*, National Economic Development and Law Center and California Research, Berkeley, February 1980, pp. 36-44; also The RAND Corporation, P-6456, March 1980.

“Foreign Experience with Peak-Load Pricing of Electricity,” *The Impact of the National Energy Act on Utilities Due to Conversion to Coal*, Information Transfer, Silver Springs, Maryland, 1979 (coauthored).

“Design of the Los Angeles Peak-Load Pricing Experiment for Electricity,” *Journal of Econometrics*, Vol. 2, No. 1, September 1979, pp. 131-194; also The RAND Corporation, R-1955-DWP, November 1976 (coauthored).

“Peak-Load Pricing of Electricity,” *Journal of Business Administration*, Vol. 10, Nos. 1 and 2, Fall 1978/Spring 1979, pp. 349-362; also in P. Nemetz (ed.), *Energy Policy – The Global Challenge*, Institute for Research in Public Policy, Montreal, 1979; also The RAND Corporation, P-6161-1, July 1978.

“Tariffe Elettriche Industriali e Modulazione dei Carichi,” in *Economia delle Fonti di Energia*, XXII, No. 6, 1978 (coauthored).

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### PROFESSIONAL EXPERIENCE

1992–present	<i>Vice President</i> , Charles River Associates, Washington, DC.
1980–1992	<i>Senior Economist</i> , The RAND Corporation, Washington, DC.
1990–1991	<i>Visiting Professor of Law and Economics</i> , Georgetown University Law Center.
1988–1989	<i>Visiting Henley Professor of Law and Business</i> , Columbia University.
1985–1988	<i>Co-editor</i> , <i>RAND Journal of Economics</i> .
1978–1980	<i>Co-director</i> , Network Inquiry Special Staff, Federal Communications Commission.
1971–1972	<i>Brookings Economic Policy Fellow</i> , Office of Telecommunications Policy, Executive Office of the President.
1965–1980	<i>Assistant Professor, Associate Professor, Professor of Economics, Allyn R. and Gladys M. Cline Professor of Economics and Finance</i> , Rice University.
1963–1965	<i>Economist</i> , Institute for Defense Analyses.
1962–1963	<i>Acting Assistant Professor of Economics</i> , University of California, Santa Barbara.

### CONSULTANCIES

1972–1978	The RAND Corporation
1972–1977	Office of Telecommunications Policy, Executive Office of the President
1975	Texoma Regional Planning Commission
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## PROFESSIONAL ACTIVITIES/HONORS

Member, Board of Editors, *Information Economics and Policy*, 1993–present.

Member, Editorial Board, *Economics of Innovation and New Technology*, 1989–present.

Member, US National Committee on Data for Science and Technology (CODATA), National Research Council, 1993–1996.

Member, Office of Technology Assessment Advisory Panel on Communications Systems for an Information Age, 1986–1988.

Member, Regional Telecommunications Planning Advisory Committee, City of Cincinnati, 1985.

Member, Office of Technology Assessment Advisory Panel on Intellectual Property Rights in an Age of Electronics and Information, 1984–1985.

Expert, World Intellectual Property Organization/UNESCO Meeting on Unauthorized Private Copying of Recordings, Broadcasts, and Printed Matter, 1984.

Listed in *Who's Who in America*, 1982–1983, 1984–1985, 1986–1987, 1988–1989, 1990–1991, 1992–1993, 1994, 1995, 1996.

Member, Editorial Board, *Southern Economic Journal*, 1979–1981.

Member, Task Force on National Telecommunications Policy Making, Aspen Institute Program on Communications and Society, 1977.

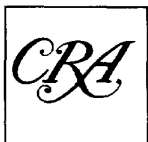
Brookings Economic Policy Fellow, 1971–1972.

Member, Technical Advisory Committee on Business Development, Model City Program, City of Houston, 1969–1971.

Wilson University Fellow, 1959–1961.

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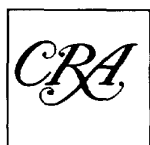
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